POW! Perspectives On the Web

ABSTRACT

The perspectives mechanism described in this paper provides a flexible approach to organizing information in a shared repository for the use of individuals and groups engaged in collaboratively constructing knowledge. The perspectives approach builds on a long history of ideas for personalizing access to information within large hypertext spaces, but the POW! perspectives server is the first example of implementing this approach on the WorldWideWeb. After reviewing the concept of perspectives as a support mechanism for Web-based collaboration, this paper will present the main features of the approach and describe common functional types of perspectives. The POW! perspectives server is currently being used in two educational applications: one an environmental course in middle school and the other a graduate seminar in cognitive science. These two collaborative learning applications will be discussed briefly. At the WebNet '99 Conference, evaluation results from these two courses will also be presented.

1. PERSPECTIVES: A COLLABORATION SUPPORT MECHANISM

The concept of perspectives comes from the hermeneutic philosophy of interpretation of Heidegger (1927) and Gadamer (1967). According to this philosophy, all understanding is situated within interpretive perspectives: knowledge is fundamentally perspectival. This is in accord with recent work in cognitive science that argues for theories of

socially situated activity and collaborative learning (e.g., Lave & Wenger, 1991; Winograd & Flores, 1986).

Collaborative work typically involves both individual and group activities. Individuals engage in personal *perspective-making* and also collaborate in *perspective-taking* (Boland et al., 1995). That is, people and communities construct not only elements of domain knowledge, but also their own "take" on the domain, a way of understanding the network of knowledge that makes up the domain. An essential aspect of making one's perspective on a domain of knowledge is to take on the perspectives of other people in the community. Learning to interpret the world through someone else's eyes and then adopting this view as part of ones own intellectual repertoire is a fundamental mechanism of learning. Collaborative learning can be viewed as a dialectic between these two processes of perspective making and perspective taking. This interaction takes place at both the individual and group levels of analysis – and it is a primary mode of interchange between the two levels.

While the Web provides an obvious medium for collaborative work, it provides no support for the interplay of individual and group understanding that drives collaboration. First, we need ways to find and work with information that matches our personal needs, interests, and capabilities. Then we need means for bringing our individual knowledge together to build a shared understanding and collaborative products. Enhancing the Web with perspectives may be an effective way to accomplish this.

As a mechanism for computer-based information systems, the term *perspective* means that a particular, restricted segment of an information repository is being considered, stored, categorized, and annotated. This segment consists of the information that is relevant to a particular person or group, possibly personalized in its display or organization to the needs and interests of that individual or team. Computer support for perspectives allows people in a group to interact with a shared community memory; everyone views and maintains their own perspective on the information without interfering with content displayed in the perspectives of other group members.

One problem that typically arises is that isolated perspectives of group members tend to diverge instead of converging as work proceeds. Structuring perspectives to encourage perspective-taking, sharing, and negotiation offers a solution to this by allowing members

of a group to communicate about what information to include as mutually acceptable. The problem with negotiation is generally that it delays work on information while potentially lengthy negotiations are underway. Here, a careful structuring of perspectives provides a solution, allowing work to continue within personal perspectives while the contents of shared perspectives are being negotiated. We believe that perspectives structured for negotiation is an important approach that can provide powerful support for collaborative use of large information spaces on the Web.

The idea of Perspectives On the Web traces its lineage to ideas like "trail blazing" (Bush, 1950), "transclusion" (Nelson, 1981), and "virtual copies" (Mittal et al., 1986) – techniques for defining and sharing alternative views on large hypertext spaces. At the University of Colorado, we have been building desktop applications with perspectives for the past decade (McCall et al., 1990; Stahl, 1993a). With the implementation of the POW! perspectives server we can now use perspectives on the Web.

2. FEATURES OF THE PERSPECTIVES MECHANISM

The perspectives mechanism that we have been exploring (Stahl, 1993b) incorporates the following features for a community of users:

- Individual community members have access to what appears to be their own information source. This is called their *personal perspective*. It consists of items from a shared central information repository that are tagged as being visible within that particular perspective (or in any perspective inherited by that perspective). This provides a workspace for perspective-making.
- Community member A can integrate an item from B's perspective into A's personal perspective by creating a *link* (or virtual copy) of the item. If B modifies the original item, then it changes in A's perspective as well. However, if A modifies the item, a new item is actually created for A with the modified content, so that B's perspective is not changed. This arrangement generally makes sense because A wants to view (or inherit) B's item, even if it evolves. However, B

should not be affected by the actions of someone who copied one of B's items.

- Alternatively, A can *physically copy* the contents of an item from B's perspective. In this case, the copies are not linked to each other in any way. Since A and B are viewing physically distinct items now, either can make changes without affecting the other's perspective. Linking and copying notes from other perspectives allows perspective-taking to occur.
- When A creates a virtual copy of an item from B's perspective, A can decide if she will also get virtual copies of items related to that one, or if she will create her own sub-network for her copy of that item. Arbitrarily large sub-networks of information can be inherited with no overhead using the linking and inheritance mechanisms.
- Items of information can be created, edited, rearranged, linked together, or deleted by users within their personal perspective without affecting the work of others.
- There is an inheritance tree of perspectives; descendants inherit the contents of their ancestor perspectives. Changes (additions, edits, deletions) in the ancestor are seen in descendent perspectives, but not vice versa.
- New perspectives can be created by users. Perspectives can inherit from one or more existing perspectives. Thus, a team perspective can be created that inherits all the content of the perspectives of the team's members. A hierarchy of team, sub-team, and individual perspectives can be built to match the needs of a particular community.

This model of perspectives has the important advantage of letting team members inherit the content of their team's perspective and other information sources without having to generate it from scratch. They can then experiment with this content on their own without worrying about affecting what others see. This is advantageous as long as one only wants to use someone else's information to develop one's own perspective.

However, if one wants to influence the content of team members' perspectives, then this approach is limited because one cannot change someone else's content directly. This limitation is overcome with the linking/copying functions and the definition of certain types of

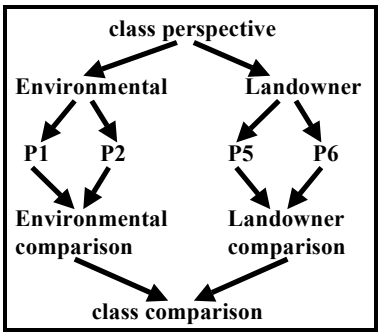

Figure 1. A typical inheritance hierarchy of perspectives. The comparison perspective includes all content from member perspectives. Results of negotiation can be added to class and team perspectives to be shared in all members' personal perspectives.

perspectives, as discussed below. It is of course important for supporting collaborative work that the perspectives maintain at least a partial overlap of their contents in order to reach successful mutual understanding and coordination. The underlying subjective opinions must be intertwined to establish intersubjective understanding (Tomaselo et al., 1993; Habermas, 1981). When we set up a new application using POW!, we structure an initial hierarchy of perspectives to support both divergent and convergent discourse among perspectives. The innovation in our collaboration applications – compared for instance to CSILE (Scardamalia & Bereiter, 1991) – is the flexible perspectives mechanism, in which content is automatically inherited down a hierarchy of perspectives and in which this hierarchy can itself evolve to meet changing user needs.

3. TYPES OF PERSPECTIVES AND PRACTICES

A typical POW! application provides several functional types of perspectives within a multi-layered graph of perspective inheritance to help students compile their individual and joint research (Figure 1). Certain social practices for using the application are associated with these different types of perspectives:

The *class perspective* is created by the teacher to start everyone off with some initial pointers and suggested topics. It typically establishes

a structure for classroom activities and provides a space for collecting the products of collaborative intellectual work.

Team perspectives contain items that have been accepted by the members of a team. This perspective is pivotal for collaboration; it gradually collects the products of a team's effort.

A student's *personal perspective* is a private work space for constructing the student's personalized perspective on the shared information. It inherits a view of everything in team perspectives of the teams to which the student belongs. Thus, it displays the owner's own work within the context of items proposed or negotiated by teams and the class – as modified by the student. Students can each modify (add, edit, delete, rearrange, link) their copies of team items in their personal perspectives. They can also create completely new material there.

The *comparison perspective* combines all the personal perspectives of team members and the team perspective, so that anyone can compare all the work that is going on. It inherits from the personal, team, and class perspectives. Students can go here to get ideas and copy items into their own personal perspective or propose items for a team perspective.

Students each enter notes in their personal perspective using information available to them: the Web, books, encyclopedia, CD-ROM, discussions, or other sources. Students can review the notes in the class perspective, their team perspectives, and the personal perspectives of their team mates. All of these contents are collected in comparison perspectives, where they are labeled by their perspective of origin. Students extract from any of these perspectives those items which are of interest to them. Then they organize and develop the data they have collected by categorizing, summarizing, labeling, and annotating. The stages of investigating, collecting, and editing can be repeated as many times as desired. Team members then negotiate which notes should be promoted to the team perspective to represent their collaborative product.

The class project ends with each team producing an organized perspective. This year's research products can be used to create next year's class perspective starting point, so new researchers can pick up where the previous generation left off – within a Web information space that will have evolved substantially in the meantime.

4. NEGOTIATING ENVIRONMENTAL PERSPECTIVES

This Fall we piloted the use of POW! in a classroom at the Logan School for Creative Learning in Denver, using both HTML and Java applet interfaces to the perspectives server. For the past five years, this class of middle school students has researched the environmental damage done to mountain streams by "acid mine drainage" from deserted gold mines in the Rocky Mountains above Denver. They actually solved the problem at the source of a stream coming into Boulder from a mine site by building a wetlands area to filter out heavy metals. This year they are investigating the broader ramifications of their past successes; they are looking at the issue of acid mine drainage from various alternative – and presumably conflicting – perspectives. The students interview adult mentors to get opinions from specific perspectives: environmental, governmental, mine-owner, and local landowners.

The POW! application serves as a medium through which students collaboratively research these issues with their mentors and with each other. Each student and mentor has their personal perspective, and these perspectives inherit from one of the content-based team perspectives (environmental protection, governmental regulation, etc.), depending upon which intellectual perspective they are working on constructing. Even email interactions happen through the application and are retained as notes in its perspectives.

A tree of discussion threads was “seeded” in the application with question categories, such as “Environmental Analysis Questions”. Within these categories, the teacher posted specific questions for the students to explore, like, “Do you believe that acid mine drainage is a serious threat to the environment?” Students can send an email to one or more mentors asking for information related to this question. When replies are sent back, they will be automatically posted to the discussion thread under the original email. When someone clicks on a title in the discussion, the contents of that item are displayed in an HTML frame below the applet (Figure 2).

A student works in her personal perspective, which might inherit from the class, student team, and landowner team perspectives. She can add, edit, and delete ideas in her perspective, as well as sending email in it. Because she is a member of the landowner team and the student

group as well as the class, she can browse ideas in the student team comparison, the landowner team comparison, and the class comparison perspective.

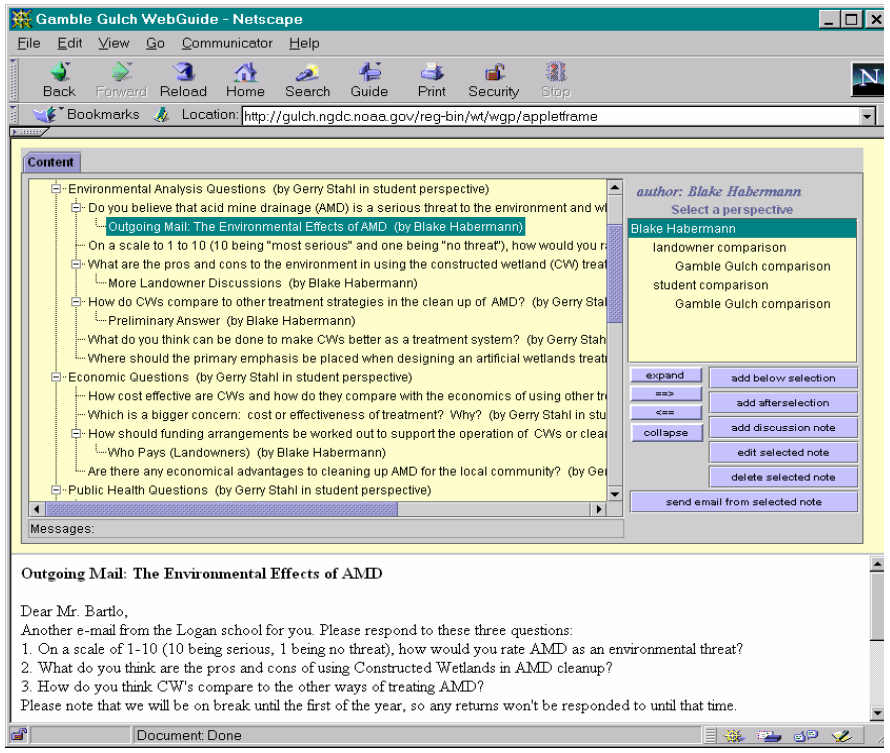

Figure 2. An interface to the POW! perspectives server. A Java applet shows a student notes in his personal perspective. An HTML frame below displays the content of a selected note.

For this application, the teacher has decided that negotiation and perspective-taking will take place in live classroom discussions, rather than within the Web application. After a team or the whole class reaches a consensus, the teacher will enter the statements that they have agreed to into the team or class perspective.

The goal of the year-long course is not only to negotiate within teams to construct the various positions, but also to negotiate among the positions to reach consensus or to clarify differences. The teacher designed this class to teach students that knowledge is perspectival, that different people construct views, compilations of facts, and arguments differently depending upon their social situation. He hopes that his students will not only learn to evaluate statements as deriving from

different perspectives, but also learn to negotiate the intertwining of perspectives to the extent that this is possible.

As an initial field testing of our system, this trial has resulted in valuable experience in the practicalities of deploying such a sophisticated program to young students over the Web. The students are enthusiastic users of the system and offer (through the application) many ideas for improvements to the interface and the functionality. Consequently, the software is benefiting from rapid cycles of participatory design. The differing viewpoints, expectations, and realities of the software developers, teachers, and students provide a dynamic field of constraints and tensions within which the software, its goals, and the understanding of the different participants co-evolve within a complex structural coupling.

5. CONSTRUCTING PERSPECTIVES ON COMPUTER MEDIATION

We have also recently begun an interdisciplinary graduate seminar on computer mediation of collaborative learning. The seminar uses a POW! application in several ways:

- *As the primary communication medium for their internal collaboration*. The seminar takes place largely on-line. Limited class time is used for people to get to know each other, to motivate the readings, to introduce themes that will be followed up on-line, and to discuss how to use the software within the seminar.
- *As an example system of computer-mediated collaboration to analyze*. Highly theoretical readings on mediation and collaboration are made more concrete by discussing them in terms of what they mean in a system like ours. The advantage of using a locally-developed prototype as our example is that we not only know how it works in detail, but we can modify its functionality or appearance to try out suggestions that arise in the seminar.
- *As an electronic workspace for members to construct their individual and shared ideas*. Ideas entered into the system persist there, where they can be revisited and annotated at any time. Ideas that arise early in the seminar will still be

available in full detail later so that they can be related to new readings and insights. The record of discussions over a semester or a year will document how perspectives developed and interacted.

- *As a glossary and reference library*. This application is seeded with a list of terms that are likely to prove important to the seminar and with a list of seminar readings. Seminar members can develop their own definitions of these terms, modifying them based on successive readings in which the terms recur in different contexts and based on definitions offered by other members. Similarly, the different readings can be discussed and interpreted on-line.
- *As a brainstorming arena for papers*. The application has already been seeded with themes that might make interesting research papers drawing on seminar readings and goals. It allows people to link notes from anywhere in the information environment to these themes and to organize notes under the themes. Thus, both individuals and groups can use this to compile, structure, and refine ideas that may grow into publishable papers. Collaborative writing is a notoriously difficult process which generally ends up being dominated by one participant's perspective or being divided up into loosely connected sections, each representing a single perspective. Software with perspectives may facilitate a more truly collaborative approach to organizing ideas on a coherent theme.
- *As a bug report mechanism or feature request facility*. Seminar participants can communicate problems they find in the software as well as propose ideas they have for new features. By having these reports and proposals shared within the Web-based medium, they are communicated to other seminar participants, who can then be aware of the bugs (and their fixes) and can join the discussion of suggestions.

The seminar version of POW! incorporates a built-in permissions system that structures the social practices surrounding the use of the system. Seminar participants each have a home personal perspective in which they can manipulate notes however they like without affecting the views in other perspectives. They can add quick discussion notes or other kinds of statements. They can edit or delete anything within their

home perspective. They can also make multiple copies or links from notes in their personal perspective to other notes there. Anyone is free to browse in any perspective. However, if one is not in ones own perspective then one cannot add, edit, or delete notes there. To manipulate notes freely, one must first copy or link the note into ones own personal perspective. The copy or link can optionally include copying (or linking) all the notes below the selected note in the tree as well. These rules are enforced by the user interface, which checks whether or not someone is in their personal perspective and only allows the legal actions.

The fact that an individual note may have different edited versions and different linking structures in different perspectives, that notes may have multiple parents within a discussion thread, that new perspectives can be added dynamically and may inherit from multiple other perspectives sets our systems apart from simple threaded discussion media. It also makes the computations for displaying notes rather complex. This is a task that definitely requires computers. By relieving people of all this bookkeeping, computer support may help people to collaborate.

The seminar application emphasizes the use of perspectives for structuring collaborative efforts to build shared knowledge. The goal of the seminar is to evolve sophisticated theoretical views on computer mediation within a medium that supports the sharing of tentative positions and documents the development of ideas and collaboration over time. A major hypothesis to be explored by the course is that software environments with perspectives can provide powerful tools for coordinated intellectual work and collaborative learning. For instance, it will explore how the use of a shared persistent knowledge construction space can support more complex discussions than ephemeral face-to-face conversations. We will explore the effectiveness of this application as a computationally-active tool to augment the knowledge construction work of a community, and report our findings at WebNet '99 in the Fall.

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